Takashi SUGAWARA* & Mikinori OGISU**: **Karyotype analysis of five species of *Asarum* (Aristolochiaceae) in Sichuan, China**

菅原 敬*・荻巣樹徳**: 中国四川省産カンアオイ属植物5種の核型

The *Asarum* species are perennial herbs distributed in eastern Asia, Europe and North America. Up to the present, the investigations on the chromosome number and karyotype of *Asarum* species have been made for the species in North America (Maekawa & Ono 1965, Sugawara 1982, Soltis 1984), Europe (Biering et al. 1976) and Japan (Tanaka 1935, Ono 1960, Yuasa & Maekawa 1976, Sugawara 1981, 1985a), but there is no report on the chromosome number or the karyotype for Chinese species of *Asarum*. In southern China that is the center of distribution and differentiation of *Asarum* and its related genera, approximately 30 species have been known including a few species which also occur in Japan (Cheng & Yang 1983). The karyological investigation on Chinese species of *Asarum* seems to be useful not only for understanding the evolutionary trend of the chromosomes, but also for elucidating the relationship among the species of the genus. Recently, we have had a chance to investigate the chromosome numbers and karyotypes of five species of *Asarum* occurring in Sichuan Province, China, and have obtained some karyological informations that are considered to be important for discussing the relationship among the species of *Asarum*. In this paper, we report the results of karyological study on these five Chinese species of *Asarum*.

Materials and methods Almost all of the plants examined in this study were collected from native habitats and a few plants were obtained from a botanical garden in China. They have been transplanted to the garden of Makino Herbarium (MAK), Tokyo Metropolitan University. The original sources and the number of individuals are shown in Tab. 1. Although there are some different views on the systematic arrangement of these species and the delimitation of the genus *Asarum* sensu lato, we follow Cheng & Yang (1983) in this paper.

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Karyological analysis was made by the following procedure. Root tips were pretreated with 0.002 M 8-hydroxyquinoline solution for 4 hr at room temperature and fixed with 45% acetic acid for 25 min. After being macerated in a 1:2 mixture of 45% acetic acid and 1N hydrochloric acid for 25 sec at 60 C, the root tips were stained with 1% acetic orcein solution for over one night. Subsequently, they were squashed with the conventional method.

The plants examined are now under cultivation and will be deposited in MAK as dried voucher specimens.

Results The chromosome numbers and the karyotypes of these five species are described here for the first time.

In *Asarum caudigerum* Hance var. *cardiophyllum* (Franchet) C. Y. Cheng & C. S. Yang (Fig. 1A), the chromosome number was counted as 2n=24 in somatic cells. The chromosomes of this species (Fig. 2A) were more or less symmetrical and gradually reduced in size, but four metacentric chromosomes (pairs no. 1 & no. 2) were slightly longer than the rest. In the karyogram were found ten submetacentric chromosomes (nos. 3, 7, 9-11). No SAT-chromosome was observed in a chromosomal complement of this species.

Asarum pulchellum Hemsley was 2n=24 in chromosome number (Fig. 1B) and showed the symmetrical karyotype mainly composed of metacentric chromosomes (Fig. 2B). In the chromosomal complement, two small chromosomes (no. 11) were easily distinguished from the other chromosomes by having a subtelocentric centromere. In addition, six submetacentric chromosomes (nos. 4, 10 & 12) were easily recognized. A secondary constriction was found near the proximal region of one arm in two metacentric chromosomes (no. 5) (see Fig. 1B), although it is not always visible.

In *Asarum caudigerellum* C. Y. Cheng & C. S. Yang (Fig. 1C), the chromosome number was counted as 2n=26 in somatic cells. The chromosomes of this species are as a whole smaller in size than those of the other species examined here. Unlike *A. pulchellum* and *A. caudigerum* var. *cardiophyllum* described above, a highly asymmetrical karyotype was observed in this species (Fig. 2C), that is, the chromosomal complement was composed of two metacentric (no. 1), two submetacentric (no. 4) and twenty-two subtelo- to acrocentric chromosomes. Four acrocentric chromosomes (nos. 10 & 11) were always recognized with certainty in a chromosomal complement.

Asarum maekawae Hara showed 2n=26 chromosomes in somatic cells (Fig.

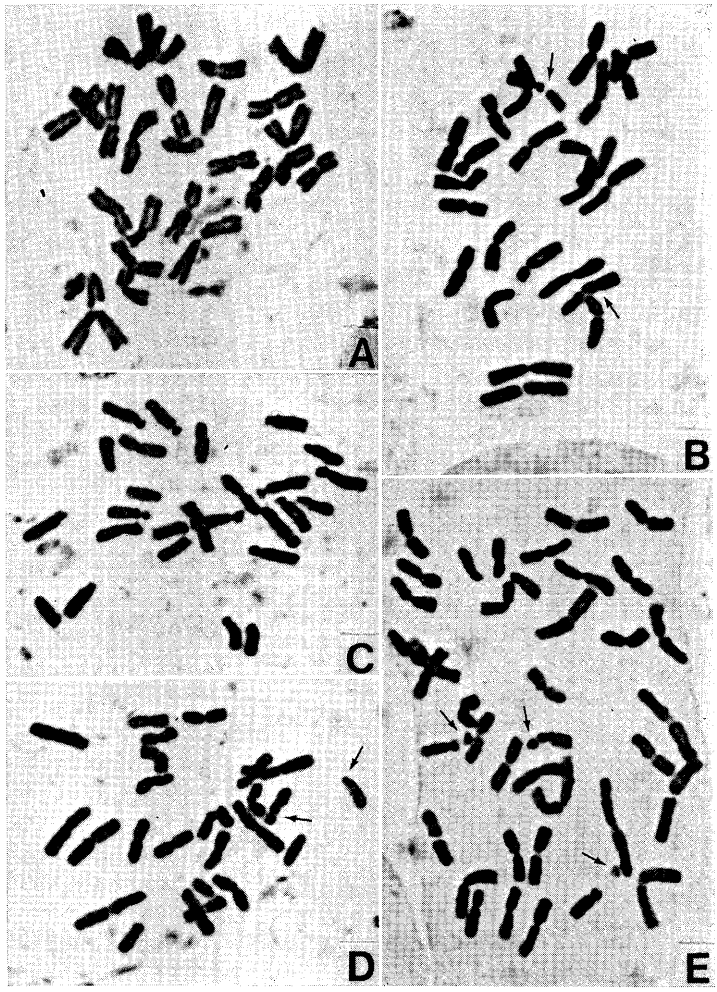

Fig. 1. Somatic metaphase chromosomes. A: *Asarum caudigerum* var. *cardiophyllum* (2n=24). B: *A. pulchellum* (2n=24) in which two small subtelocentric chromosomes are readily identified. C: *A. caudigerellum* (2n=26) showing a highly asymmetrical karyotype. D: *A. maekawae* (2n=26). E: *A. delavayi* (2n=39). Arrows show the secondary constrictions or the SAT-chromosomes found obviously. All: ×1500.

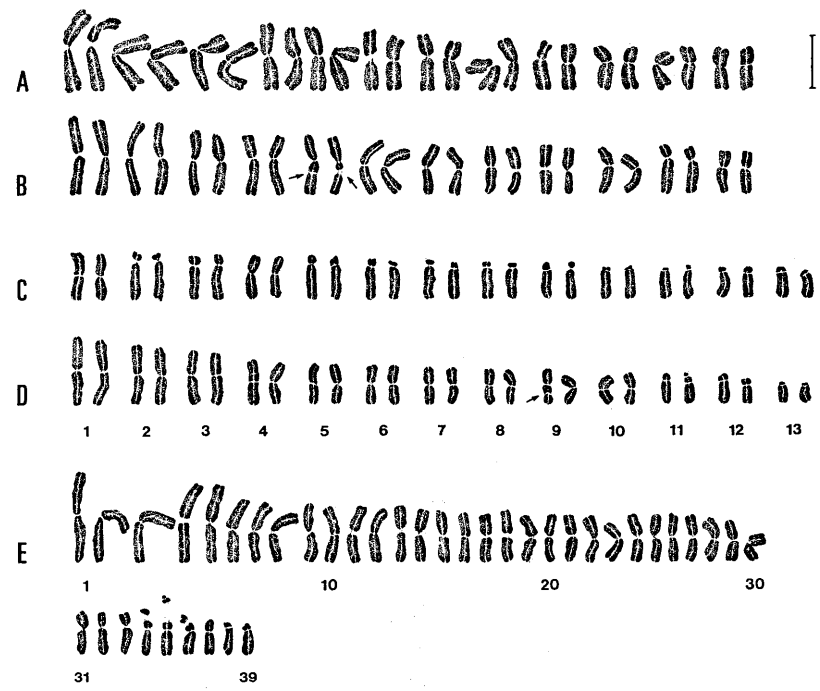

Fig. 2. Serial arrangement of the somatic metaphase chromosomes. *A*: *Asarum caudigerum* var. *cardiophyllum* (2n=24). B: *A. pulchellum* (2n=24). C: *A. caudigerellum* (2n=26). D: *A. maekawae* (2n=24). E: *A. delavayi* (2n=39). Arrows show secondary constrictions. Bar: 5 μm.

1D). The karyotype of this species was represented by 10 pairs of metacentric chromosomes and three pairs of small subtelocentric ones (Fig. 2D). The two metacentric pairs (nos. 1 & 2) were somewhat longer than the rest. One of the three subtelocentric pairs (no. 11) had a satellite on each of the short arm. A secondary constriction was observed near the middle region of one arm in two metacentric chromosomes (see Fig. 1D), but it was not always observed.

In *Asarum delavayi* Franchet (Fig. 1E), the chromosome number was counted as 2n=39 in somatic cells in all three individuals obtained from different sources. This species may be triploid. The chromosomes of this species were gradually reduced in size, but five chromosomes were somewhat longer in length than the rest (Fig. 2E, nos. 1-5). In the karyogram, three small chromosomes (nos. 34, 35 & 36) were easily distinguished from the other chromosomes by

having a subtelocentric centromere and a satellite on each of the short arm. In a chromosomal complement were furthermore found six small subtelocentric chromosomes (nos. 31-33, 37-39), two of them having a very short arm. The other chromosomes were mostly metacentric. It is now uncertain whether the plant with the triploid chromosome number (2n=39) is growing widely in wild habitat in China or not.

Discussion Among the three species of subgenus Asarum examined here (see Tab. 1), *Asarum pulchellum* and *A. caudigerum* var. *cardiophyllum* are similar in having 2n=24 chromosomes and a more or less symmetrical karyotype, although a slight difference is recognized between their chromosomal complements (see Figs. 2A & 2B). As reported in the previous paper (Sugawara 1981), such a karyotype was also shown in *A. leptophyllum* Hayata occurring in southwestern part of Japan. Especially, *A. caudigerum* var. *cardiophyllum* is more similar to *A. leptophyllum* in karyotype than to *A. pulchellum*.

Maekawa (1953) regarded *A. pulchellum* as being closely allied to *A. epigynum* Hayata and *A. geophyllum* Hemsley, and he placed them together in the genus *Geotaenium* segregated from *Asarum*. As already reported by Sugawara (1982), *A. epigynum* has 2n=12 in chromosome number and a highly asymmetrical karyotype. On the other hand, *A. pulchellum* has 2n=24 in chromosome number as presented here and a more or less symmetrical karyotype. Based on the difference of their karyotypes, the 2n=24 chromosomes found in *A. pulchellum* is not considered to be derived from doubling of the 2n=12 chromosomes in *A. epigynum*, and thus the two species seem to be far related each other in karyological aspects.

Although *Asarum caudigerellum* has the chromosome number 2n=26 which is the same number as most of the species of the subgenus Asarum hitherto examined (excluding *A. caudigerum* var. *cardiophyllum*, *A. leptophyllum* and *A. pulchellum*, each of them having 2n=24, and *A. epigynum* with 2n=12), this species is remarkably distinct in having a peculiar karyotype mainly composed of subtelo- to acrocentric chromosomes. According to Cheng & Yang (1983), this species was considered to be allied with *A. epigynum*, and these two species were assigned to the same section within the subgenus Asarum (see Tab. 1). In this study, however, it is evident that the two species are remarkably different each other in chromosome number and karyotype.

Asarum maekawae and *A. delavayi* have been assigned to the sect.

Tab. 1. Materials, chromosome numbers, localities and number of individuals examined.

Species	Chromosome number (2n)	Locality[1)]
Subg. Asarum		
sect. Asarum		
Asarum caudigerum Hance var. *cardiophyllum* Cheng & Yang	24	Mt. Emei, alt. 1100 m (4)
A. pulchellum Hemsley	24	Mt. Emei, alt. 1100 m (1) Mt. Jinfo, alt. 1600 m (1)
sect. Brevituba		
A. caudigerellum Cheng & Yang	26	Mt. Emei, alt. 1800 m (2)
Subg. Heterotropa		
sect. Heterotropa		
A. maekawae Hara	26	Mt. Emei, alt. 1550 m (3)
A. delavayi Franchet (=*Heterotropa splendes* F. Maek.)	39	Mt. Emei, alt. 1100–1200 m (1) Chengdu (1). Wuhan Bot. Inst. (1).

[1)] The number of individuals examined was put in parentheses.

Heterotropa, subg. Heterotropa (see Tab. 1) (Cheng & Yang 1983, Hara 1984), although Maekawa (1982) had raised this section to the genus *Heterotropa*. Up to the present, it has been reported that all the species of this section so far examined have the same basic number x=12 (Tanaka 1935, Ono 1960, Yuasa & Maekawa 1976, Sugawara 1981, 1985a). Nevertheless, the two species, *A. maekawae* (2n=26) and *A. delavayi* (2n=39), have a basic number x=13, and thus they are clearly different in basic number from the other species of the sect. Heterotropa occurring in Japan. The basic number x=13 of these two species is the same as those of the species of subg. Asarum occurring in Japan and North America as well as sect. Asiasarum, subg. Heterotropa in eastern Asia and sect. Hexastylis, subg. Heterotropa in eastern North America (Sugawara 1981, 1982, Soltis 1984). However, their karyotypes can be regarded as being identical with those of the species of sects. Asiasarum and Hexastylis, especially by having three pairs of small subtelocentric chromosomes. Therefore, these two species may be regarded as having a close relationship with the species of sects. Asiasarum and Hexastylis rather than the species of sect. Heterotropa in karyological features.

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References

Biering, W.E., I. Bungert-Hansing & H. Jork 1976. Ist es Gerechtfertigt, bei *Asarum europaeum* von chemischen Rassen zu Sprechen? Planta Medica **29**: 133–147. Cheng, C.Y. & C.S. Yang 1983. A synopsis of the Chinese species of *Asarum* (Aristolochiaceae). J. Arnold Arbor. **64**: 565–597. Hara, H. 1984. Comments on the East Asiatic plants (15). Journ. Jap. Bot. **59**: 225–236. Maekawa, F. 1953. Geohistorical distribution of East Asiatic Asaraceae. Proc. VII Pacific Sci. Congr. (Wellinton) **5**: 217–219. ——— 1982. A new *Heterotropa* from Mt. Omei, China. Journ. Jap. Bot. **57**: 261–263. ——— & M. Ono. 1965. Karyotype analysis in the genus *Hexastylis* (Aristolochiaceae). J. Fac. Sci. Univ. Tokyo III **9**: 151–159. Ono, M. 1960. Studies on *Heterotropa* and its related genera with special reference to their karyo-morphology and phylogeny. J. Fac. Sci. Univ. Tokyo III **7**: 437–499. Soltis, D.E. 1984. Karyotypes of species of *Asarum* and *Hexastylis* (Aristolochiaceae). Syst. Bot. **9**: 490–493. Sugawara, T. 1981. Taxonomic studies of *Asarum* sensu lato I. Karyotype and C-banding pattern in *Asarum* s. str., *Asiasarum* and *Heterotropa*. Bot. Mag. Tokyo **94**: 225–238. ——— 1982. Taxonomic studies of *Asarum* sensu lato II. Karyotype and C-banding pattern in two species of *Hexastylis* and *Asarum epigynum*. Bot. Mag. Tokyo **95**: 295–302. ——— 1985a. Further investigations on karyotype and C-banding pattern in seven species of *Heterotropa*. Journ. Jap. Bot. **60**: 15–23 (includ. Pl. I). Tanaka, N. 1935. Cytological studies in Asaraceae. Bot. Mag. Tokyo **49**: 709–716. Yuasa, H. & F. Maekawa 1976. Chromosomes of *Asarum* and *Heterotropa* (Aristolochiaceae) in the Ryukyu Islands. La Kromosomo II-1: 8-18 (in Japanese).

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中国に生育する約30種のカンアオイ属 (*Asarum* s.l.) 植物の染色体数及び核型については全く報告がない。最近，四川省峨眉山周辺に生育する5種の核型を分析し，カンアオイ属植物の類縁を論ずる上で重要と思われるいくつかの事実を得たので報告する。従来，フタバアオイ群 (*Asarum* s.str.) の各種は，そのほとんどが 2n=26 の染色体数

をもつと報告されてきたが，*A. pulchellum* ならびに *A. caudigerum* var. *cardiophyllum* は 2n=24 で，その核型は沖縄等に生育する *A. leptophyllum* に類似していた。また，*A. caudigerellum* は 2n=26 の染色体数であるが，その核型はほとんど次端部型染色体からなり，日本や北米の同群の種とは著しく異なっていた。一方，狭義のカンアオイ群 (*Heterotropa*) の各種は，これまでその基本数がすべて x=12 であると報告されてきたが，中国産の2種，*A. maekawae* (2n=26) と *A. delavayi* (2n=39) は x=13 であり，その核型は北米東部のアメリカカンアオイ群 (*Hexastylis*) や東アジアのウスバサイシン群 (*Asiasarum*) に似ていることが明らかとなった。

○東京湾沿岸に帰化したユメノシマガヤツリ(新称)について(浅井康宏・小山鐵夫) Yasuhiro ASAI & Tetsuo KOYAMA: *Mariscus congestus* (Cyperaceae) as a new adventive to Tokyo Bay

東京湾沿岸の埋立地である通称“夢の島”一帯には，市街地からの種々な廃棄集積物などに由来するもののほか，東京港へ入航する国外からの船舶に随伴して侵入する多種多様の外来植物が散見される(江東区の野草，1984)。ところで筆者の1人浅井は，この数年にわたり本地域の帰化植物を調査，同定する機会を得，多くの関係者諸氏から提供された貴重な標本(資料)および現地での実地踏査の際に得た生品をもとに，鋭意検討を行ってきた。その間において，該地域にかなり大形のカヤツリグサ科の一種が生育していることに気付き，小山と共同で検討を進めた結果，我国への新しい帰化植物 *Mariscus congestus* (Vahl) C.B. Clarke であることが判明したので，ユメノシマガヤツリと新称し，報告しておくこととした。

その概形を記せば，次のようなものである。

多年草で短い根茎があり，疎に叢生する。稈は高さ 30-70 m，硬く，平滑，基部はやや肥厚する。葉は線形で幅 4-6 mm，稈より少し短く，先は尖り，基部の鞘は紫褐色を帯びる。葉状苞は 3-4(-6)個，下方の1-3個は長く，花序の3-5倍長に及ぶ。繖形花序は単純または一部やや複生，繖梗は2-7個，斜上，(1-)5-12 cm，平滑である。各梗の先端に球状，径 2-3 cm で稍密な花穂を1個着けるが，大形の花穂では，その基部に略無梗で小形の側穂を着けて複生状となる。小苞は鬚状，長さは 1-4 cm である。小穂は短い穂軸上に殆んど放射状に着き，幅狭い披針形，先は尖り，長さは 1-2 cm，幅は 1.5-2 mm，圧扁の四角柱状で赤褐色または多少血赤色を帯び，稍密に 7-16 花を生じる。小穂の基部に関節がある。小軸には幅狭い翼があり，稍左右に屈曲する。頴は略立ち，心もち疎着，長楕円形で先は尖り，長さは 3-4 mm，7-9本の脈があり，辺縁は薄膜質で芒はない。瘦果は長倒卵形，三稜があり，長さは 1-1⅓ mm，熟して黒っぽい。花柱は